March 28, 1967 E. KIEFER 3,311,199

HYDRAULIC TELESCOPIC DAMPING DEVICES, PARTICULARLY FOR MOTOR VEHICLES

Filed Oct. 14, 1965 2 Sheets-Sheet 1

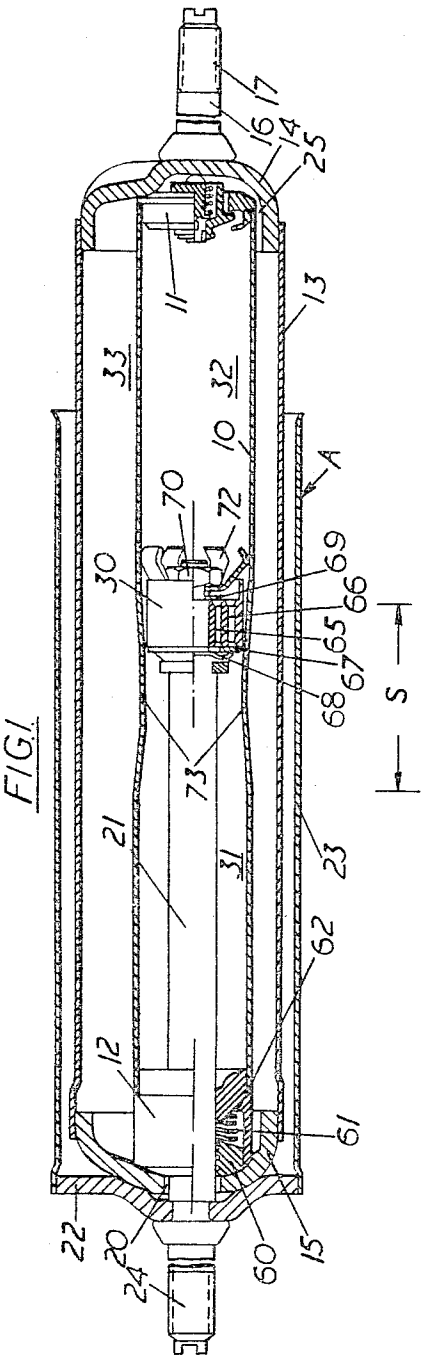


FIG. 1

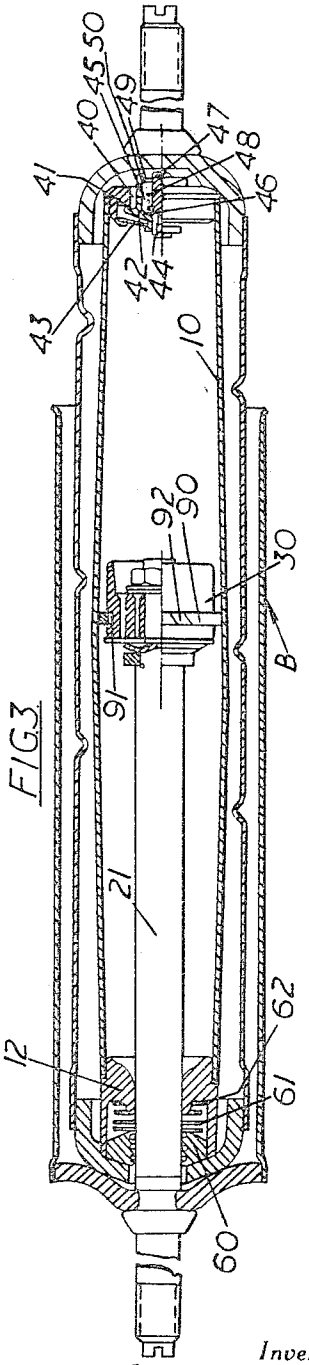


FIG. 3

Inventor
EDWIN KIEFER

By Gilbert T. Mann
Attorney

March 28, 1967 E. KIEFER 3,311,199

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Filed Oct. 14, 1965 2 Sheets-Sheet 2

FIG 2

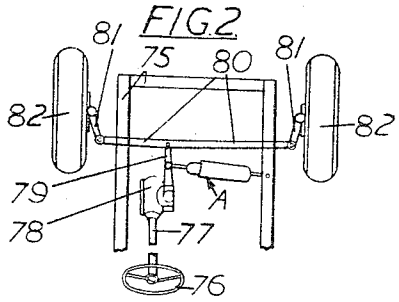


FIG 4

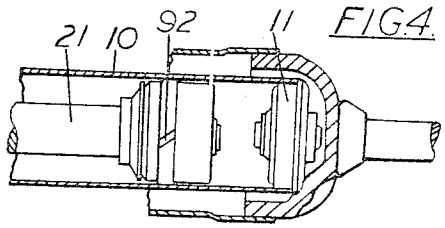
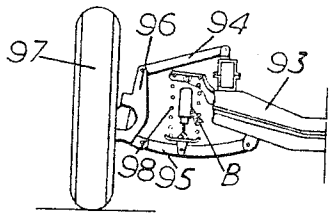


FIG 5



Inventor
EDWIN KIEFER

By John T. Reeves
Attorney

United States Patent Office

3,311,199

Patented Mar. 28, 1967

3,311,199

HYDRAULIC TELESCOPIC DAMPING DEVICES, PARTICULARLY FOR MOTOR VEHICLES

Edwin Kiefer, Russelsheim (Main), Germany, assignor to General Motors Corporation, a corporation of Delaware

Filed Oct. 14, 1965, Ser. No. 496,002
Claims priority, application Germany, Oct. 22, 1964, O 10,458
1 Claim. (Cl. 188—88)

This invention relates to hydraulic telescopic damping devices, for example for use in steering linkages and wheel suspension systems of motor vehicles.

The invention is concerned with a hydraulic telescopic damping device which is relatively simple and can be made relatively cheaply by series production, and gives a progressive damping action during its stroke.

In its broadest aspect the invention is a hydraulic telescopic damping device comprising a tube whose inside diameter varies over its length, a damper piston slidable with clearance in the tube, a guide member mounted on the piston and resiliently engaging the interior of the tube, and means for varying the effective flow cross-section between the piston and the tube in dependence on the axial position of the piston in the tube.

When the device is to be used in a motor vehicle steering linkage the inside diameter of the tube within which the damper piston is slidable may diminish from the two ends towards the central portion of the tube, whereas when the device is to be used in a motor vehicle suspension system the inside diameter of the tube may diminish towards the two ends, that is, the tube may be made somewhat barrel-shaped.

In the application of the device to a steering linkage, the relatively small effective flow cross-section and the resulting relatively large resistance to movement in the straight-ahead position of the linkage causes turning impulses due to "shimmy" of the front wheels to be damped to such an extent that they are barely perceptible at the steering wheel. On the other hand, when the steering linkage moves into the cornering position, the damper piston leaves the mid-position and reaches the region of larger tube diameter, whereby, the damping action falls off rapidly. The result is that, at large steering wheel deflections, the device does not increase the steering effort required. Moreover, the self-centering action of the steering system is not impeded, and indeed, upon release of the steering wheel subsequent to cornering, the steering is prevented from passing through the straight-ahead position and then swinging back again. In other words, the damping action of the device remains limited to the mid-position.

In the application of the device to wheel suspension, spring "break-through" at the end of a wheel bump stroke on very uneven terrain can be avoided, whereas within the range of normal spring movements the ride comfort remains unaltered. Again, the highly progressive increase in damping which can be obtained towards the end of a stroke is particularly desirable because it is in the region of the ends of the stroke that the piston speed, and correspondingly the damping, is lowest.

The guide member which is mounted on the piston and resiliently engages the interior of the damper tube serves to guide the damper piston and prevent rattling noises.

According to a preferred and highly advantageous embodiment of the invention, the guide member comprises a piston ring which is accommodated in a circumferential groove formed in the piston and has its outer periphery in resilient engagement with the interior of the tube within which the damper piston is slidable, and, to effect the

variation in the effective flow cross-section between the damper piston and the tube, a gap in the piston ring gives an effective flow cross-section which is determined by the internal diameter of the tube at the outer periphery of the piston ring. Thus the piston ring gap increases or diminishes, depending upon whether the damper piston is in a wide or narrow region of the tube. This arrangement permits particularly simple and very accurate adjustment of the damping action.

In the accompanying drawings:

FIGURE 1 is a longitudinal section through one embodiment A of a damping device according to the invention, suitable for a motor vehicle steering system;

FIGURE 2 is a schematic illustration of how the damping device shown in FIGURE 1 may be installed in a motor vehicle steering system;

FIGURE 3 is a longitudinal section through a second embodiment B of a damping device according to the invention, suitable for a motor vehicle wheel suspension system;

FIGURE 4 is a longitudinal section corresponding to the right-hand portion of FIGURE 3, but with the damper piston shown in a position different from that in FIGURE 3; and

FIGURE 5 is a schematic illustration of how the damping device shown in FIGURES 3 and 4 may be installed in a wheel suspension system for a motor vehicle.

In both the embodiments A and B, the damping device comprises a tube **10** at one end of which a base valve **11** is mounted, the other end being closed by a closure member **12**.

The tube **10** is surrounded by an outer tube **13** to the respective end portions of which caps **14** and **15** are welded. A rod **16** having a threaded attachment portion **17** is welded to the cap **14**, and a hole **20** in the cap **15** slidably accommodates a piston rod **21**. An annular disc **22** is secured to the piston rod **21**, and has one end of a protective tube **23**, forming a stone guard, welded to its periphery. At the outer end of the piston rod **21** there is a threaded attachment portion **24**, and to the inner end of the piston rod **21** there is secured a damper piston **30** which divides the inner space of the damping device into chambers **31** and **32**.

By means of the base valve **11** and adjacent passages **25**, the chamber **32** is in communication with a compensation chamber **33** which is formed between the outer tube **13** and the tube **10**, and constitutes a hydraulic reservoir.

As shown in FIGURE 3, the base valve **11** has a central aperture **40** having an annular seating face **41** for an inlet valve **42** which is resiliently biased against the seating face **41** by an inwardly extending finger spring **43**. The inlet valve **42** has two concentric bores **44** and **45** having different diameters, and between the bores **44** and **45** a conical seating surface **46**. A valve **47** is guided in an axially displaceable manner in the narrower bore **44**. A helical compression spring **48** has one end seated against the valve **47** for biasing the valve against the conical seating surface **46**, and its other end seated against an annular member **49** which is held in a groove **50** of the inlet valve **42**. If the damper piston **30** moves towards the base valve **11**, the valve **42** is lifted from its seating surface **46** in opposition to the bias of the spring **48**, with the result that fluid displaced by the piston rod **21** can flow out of the chamber **32** into the compensation chamber **33**. Conversely, if the damper piston **30** moves away from the base valve **11**, the inlet valve **42** is lifted from its seating face **41** in opposition to the bias of the spring **43**, so that fluid flows back from the compensation chamber **33** into the chamber **32**.

For sealing off the damping device, a packing seal **60**

is biased against the cap **15** by a spring **61** which is seated in an annular groove **62** in the closure member.

The damper piston **30** has two rings of throttle passages **65** and **66** distributed uniformly round its periphery. The outer ring of throttle passages **66** is controlled by a spring plate **67** which is biased by a spring **68**, and the inner ring of throttle passages **65** is controlled by a spring plate **69**. The various parts are attached to the piston rod **21** by means of a nut **70**.

In the embodiment A which is shown in FIGURE 1, a guide member for guiding the piston **30** in the tube **10** is constituted by a claw member **72** which resiliently engages the interior of the tube. The inside diameter of the tube **10** diminishes from the two ends towards the central portion of the tube; thus, at the middle of the piston movement, the tube **10** has a narrow portion, designated **73**. The result of this construction is that the damping action of the device is confined to a middle region, designated S; outside this region, the damper fluid can pass round the outside of the damper piston **30**.

FIGURE 2 shows how the damping device A can be arranged in a motor vehicle steering system. **75** denotes the front end of the frame of a motor vehicle. **76** is the steering wheel, **77** the steering column and **78** the steering gear, from which steering movements are transmitted via a steering arm **79** to a track rod **80**, and from the opposite ends of the latter by way of respective steering levers **81** for the stub axles (not shown) and thereby to the wheels **82**. The damping device A is arranged substantially horizontally between a fixed part of the vehicle, namely the frame **75**, and a movable part of the steering linkage, namely the steering arm **79**. On account of this horizontal arrangement, in the embodiment shown in FIGURE 1 the tube **10** is disposed eccentrically with respect to the outer tube **13**. For the same reason, the passages **25** are placed low. The device is so installed that the tube **10** is as low as possible (as is shown in FIGURE 1), to ensure an adequate fluid level above the base valve **11** at all times. This configuration of the steering system gives the advantage that, when the vehicle is traveling straight ahead, shimmy-inducing impacts are effectively damped, whereas throughout a substantial range of off-centre steering positions the steering effort is not increased by the device, because the damping effects are negligible.

In the embodiment B shown in FIGURE 3, a guide member for guiding the damper piston **30** in the tube **10** is constituted by a piston ring **90** which is accommodated in a groove **91** in the damper piston and has its outer periphery in resilient engagement with the interior of the tube **10**. The inside diameter of the tube **10** diminishes towards the two ends of the tube, and, to effect the variation in the effective flow cross-section between the damper piston **30** and the tube **10**, a gap **92** in the piston ring **90** can be partially closed by compression of the piston ring as the damper piston **30** slides towards its extreme positions, such that the gap **92** gives an effective flow cross-section which is determined by the internal diameter of the tube **10** at the outer periphery of the piston ring **90**.

The resulting increased flow resistance causes an increase in the damping action, so that spring breakthrough movements are damped especially strongly. The increase in the damping action at the end of the stroke is also desirable to compensate for the low piston speeds near the ends of the stroke, since damping would otherwise be low at these low piston speeds.

FIGURE 4 illustrates the reduced piston ring gap **92** when the damper piston reaches the end of its stroke. In the central portion of the stroke, specifically in the operating range with the vehicle at tare or moderate design loading, the piston ring gap **92** is so great that there is scarcely any damping effect. Thus within the normal operating range, better ride comfort is attained.

The tube **10** may be produced by pressure shaping or by explosive forming.

FIGURE 5 shows how the damping device B can be installed in a front wheel suspension. Upper and lower links **94** and **95** are pivotally mounted on a vehicle frame or sub-frame **93**, with their outer ends pivotally connected to a steering knuckle **96** to which in turn the wheel **97** is pivotally attached. A helical compression spring **98** is interposed between the frame **93** and the lower link **95**. The damping device B is positioned inside the helical spring **98**, with one of its ends pivotally connected to the frame **93** and its other end pivotally connected to the lower link **95**.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

A hydraulic shock absorber comprising an outer reservoir tube, closure means for sealing ends of said reservoir tube, a second tube located interiorly of said reservoir tube and extending throughout the length of said reservoir tube, said second tube having a varying cross-sectional area diminishing from the center thereof toward either end of said tube, piston means relatively reciprocal in said second tube including centering means thereon for slidably centering said piston means during travel thereof throughout the total length of said second tube, said centering means including means for bleeding fluid from one side of said piston means to an opposite side thereof during travel of said piston means in said second tube proportionally to the cross-sectional area of said second tube at the point said piston means is traveling with respect to said second tube, said bleed means including a split ring of resilient material having a gap therein acting as a variable orifice for diminishing fluid flow across said split ring as said piston means traverses a relatively narrower diameter portion of said second tube and which provides a larger variable bleed orifice as said piston means traverses a relatively larger diameter portion of said second tube.

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MILTON BUCHLER, *Primary Examiner.*

G. E. A. HALVOSA, *Assistant Examiner.*